

Broad Base. Best Solutions.



SGL Group The Carbon Company

Company Profile

Siegfried Rauch | September 2017

DC0 Öffentlich - (rauchsi)

SGL Group is one of the world's largest manufacturers of carbon-based products

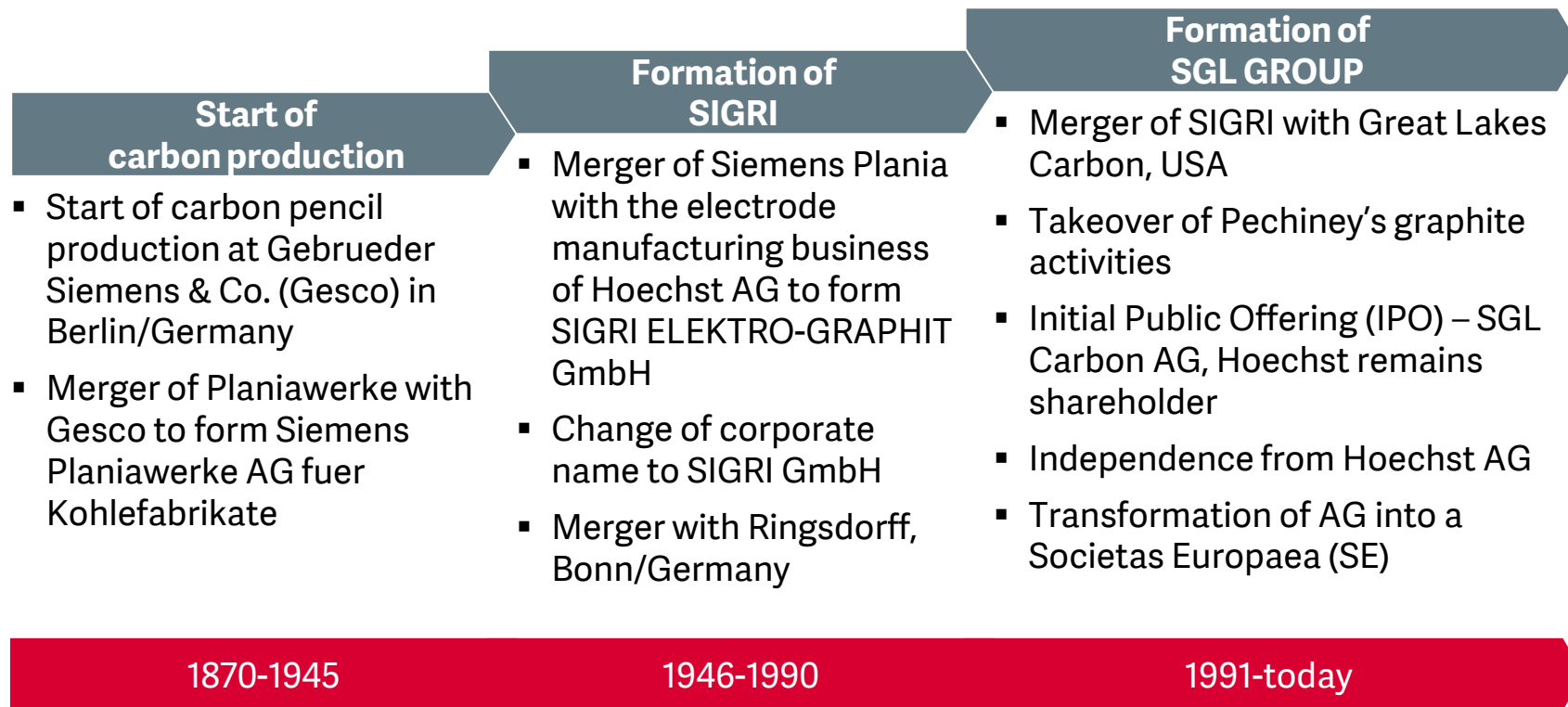


SGL Group today

- Comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites
- More than 33 production sites worldwide
- Service network covering more than 100 countries
- Sales of €770 million in 2016*
- Head office in Wiesbaden/Germany
- Approx. 3,950 employees worldwide*
- Listed on Deutsche Boerse's SDAX

* Sales revenue/no. of employees from continuing operations

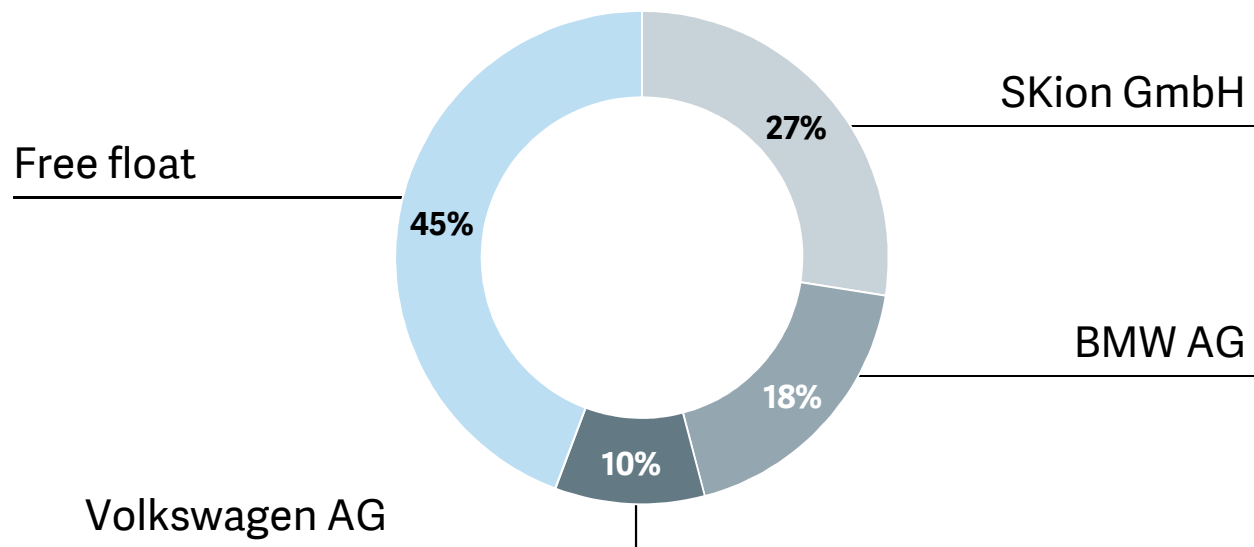
SGL Group is a young company with a long tradition



SGL CARBON SE is an independent, publicly listed company backed by reputable anchor investors



Shareholder structure*



* reported shareholdings according to §§21 f. WpHG, last notification BMW AG and Skion GmbH Oct 15, 2014, VW AG Jun 1, 2016

BU CFM* supplies high-performance products based on carbon, glass, and aramid fibers



Customers from growth industries like wind energy, sports equipment, automotive, and aerospace benefit from SGL Group's vast expertise in composite technology



Oxidized fibers



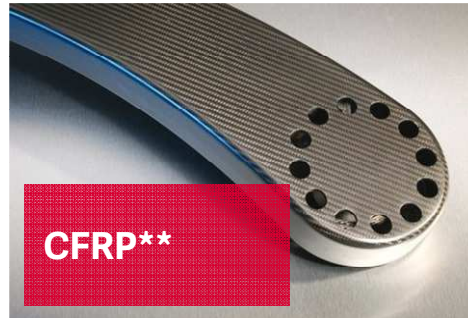
Carbon fibers



Textiles



Prepregs



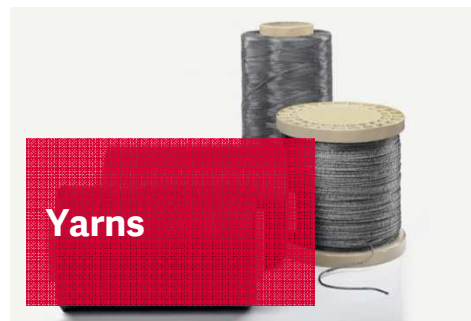
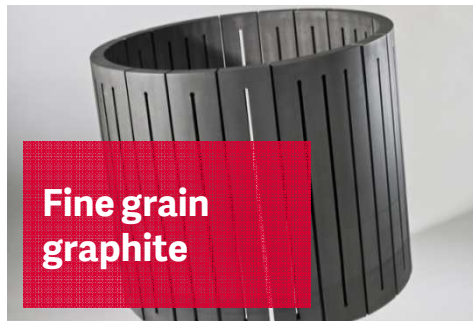
CFRP**

* CFM: Composites - Fibers & Materials, **CFRP: Carbon fiber-reinforced plastic

BU GMS* supplies more than 35 industries with its advanced material, equipment, and process solutions



SGL Group is one of the world's leading manufacturers of specialty graphites and a premium provider for equipment and systems for the process technology



* Graphite Materials & Systems
DC0 Öffentlich - (rauchsil)

Introduction to Expanded Graphite

Product Group Expanded Graphite



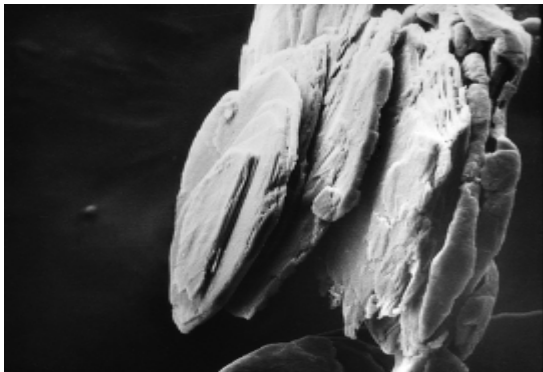
Oxidation test



Conclusion of short term test with „Carbolite“ Oven

| | SIGRAFLEX | Standard-Qualität |
|--------------------|-----------|-------------------|
| initial weight [g] | 0,166 | 0,17 |
| final weight [g] | 0,164 | 0,094 |
| loss in mass [%] | 1% | 45% |

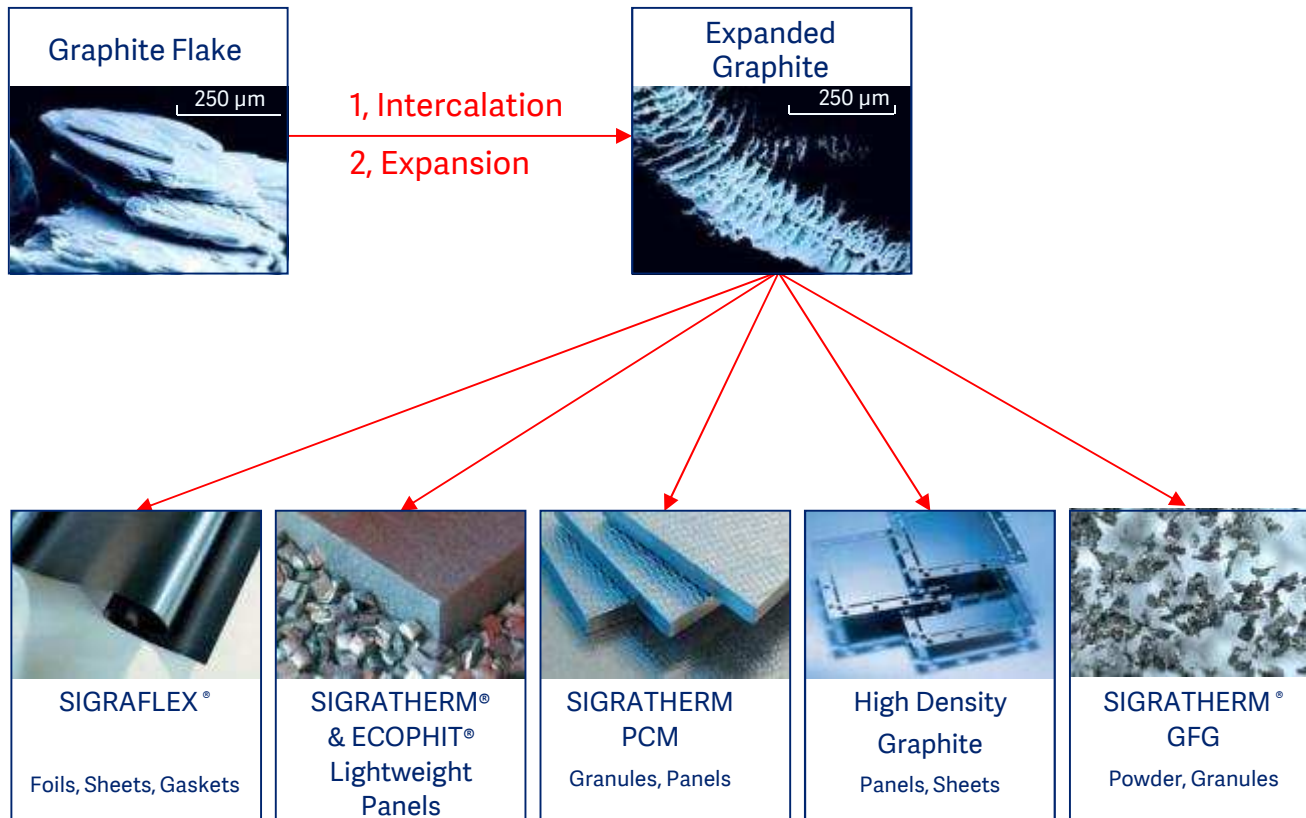
Raw Material Properties influence the Quality of the Foil and Sheet



Main aspects of the utilized raw material – Natural Graphite -

- Purity or amount of Ash content
- Content of the Ash
- Structure of the Natural Graphite

Expanded Graphite Product Overview



Expanded Graphite : SIGRAFLEX from natural graphite for sealing systems

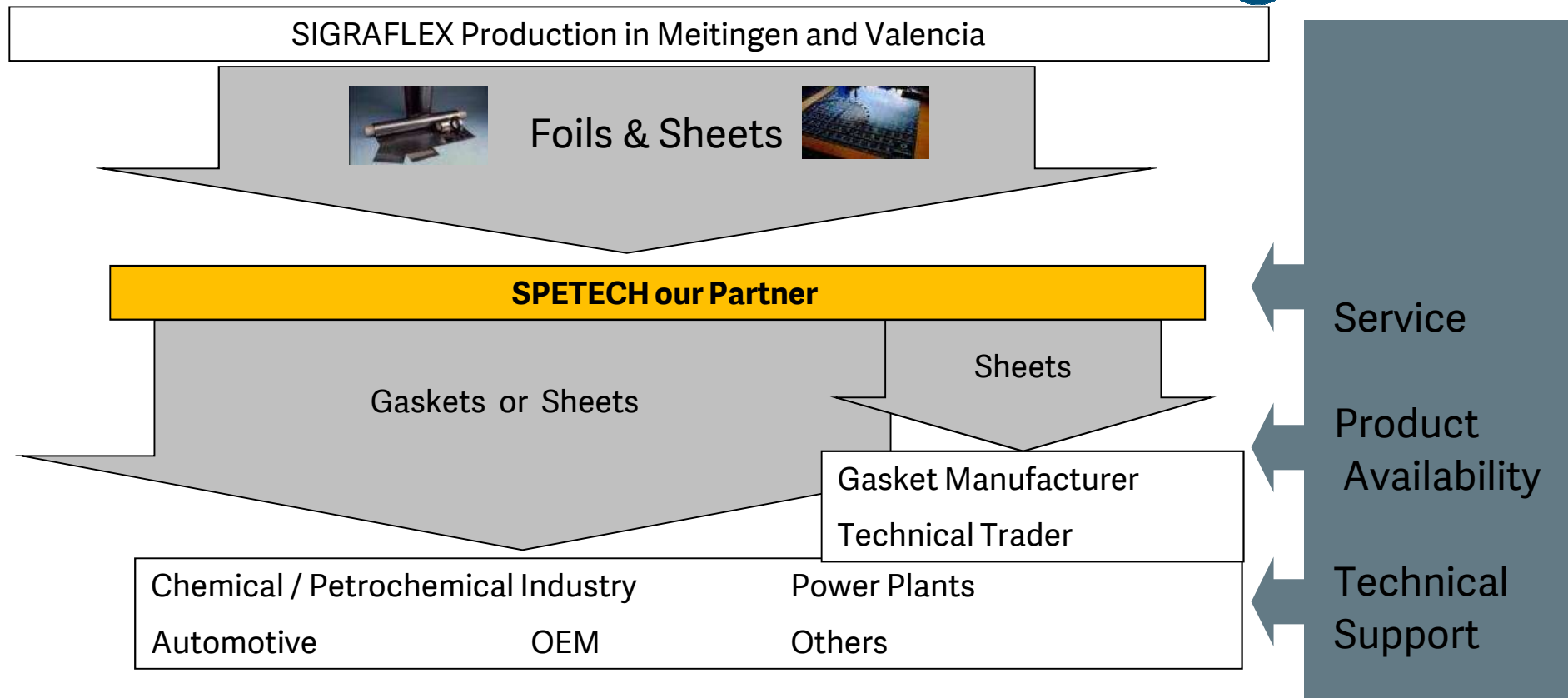


Foil

Sheets

Yarns

Technical Sales of Expanded Graphite



Graphite foil is transformed into sealing material



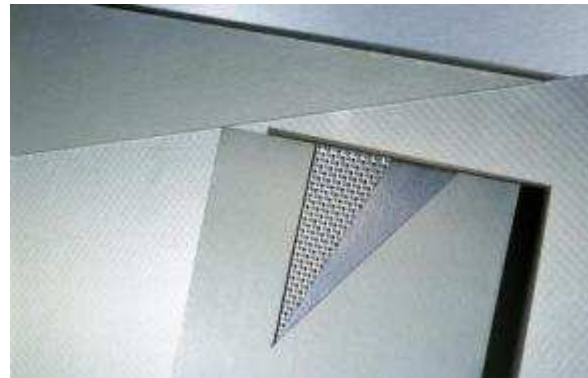
Tapes / Packing rings / Spiral wound



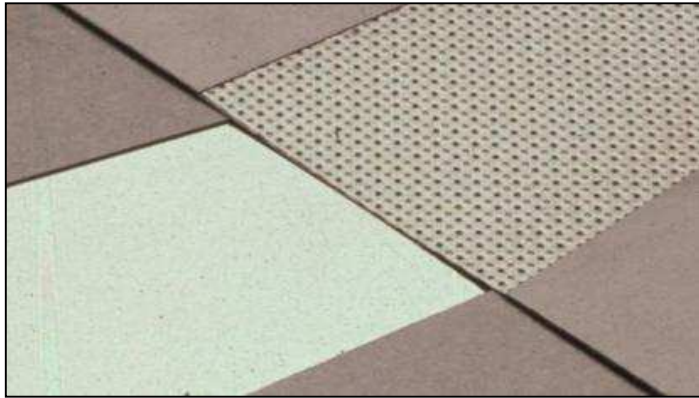
Kammprofile gaskets



Metal reinforced graphite foils
mechanical / adhesive bonded / adhesive free



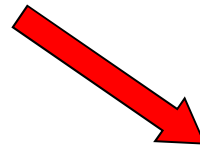
Connection of Stainless Steel Foil to Graphite Foil



Quality features are:

- Welding of stainless steel
- Impregnation
- Free of adhesive / fillers
- Branding

Graphite Sealing Sheet



SIGRAFLEX Sheets in Big Dimension



Stainless steel foil 50 μm / 100 μm is only available up to 1000 mm width on the world market!

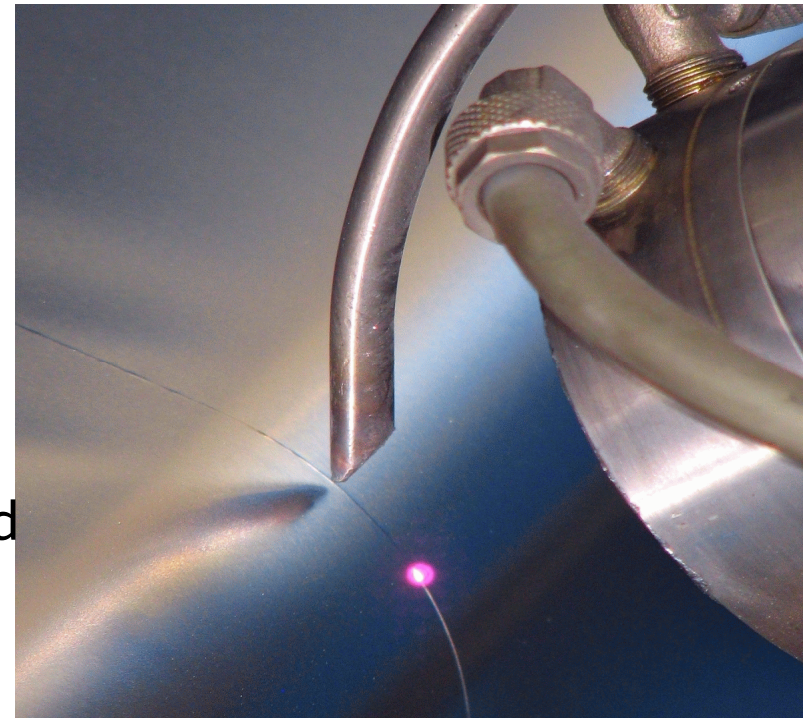
Therefore no homogenous 1500 x 1500mm sheets are available!!

Competitors make them by:

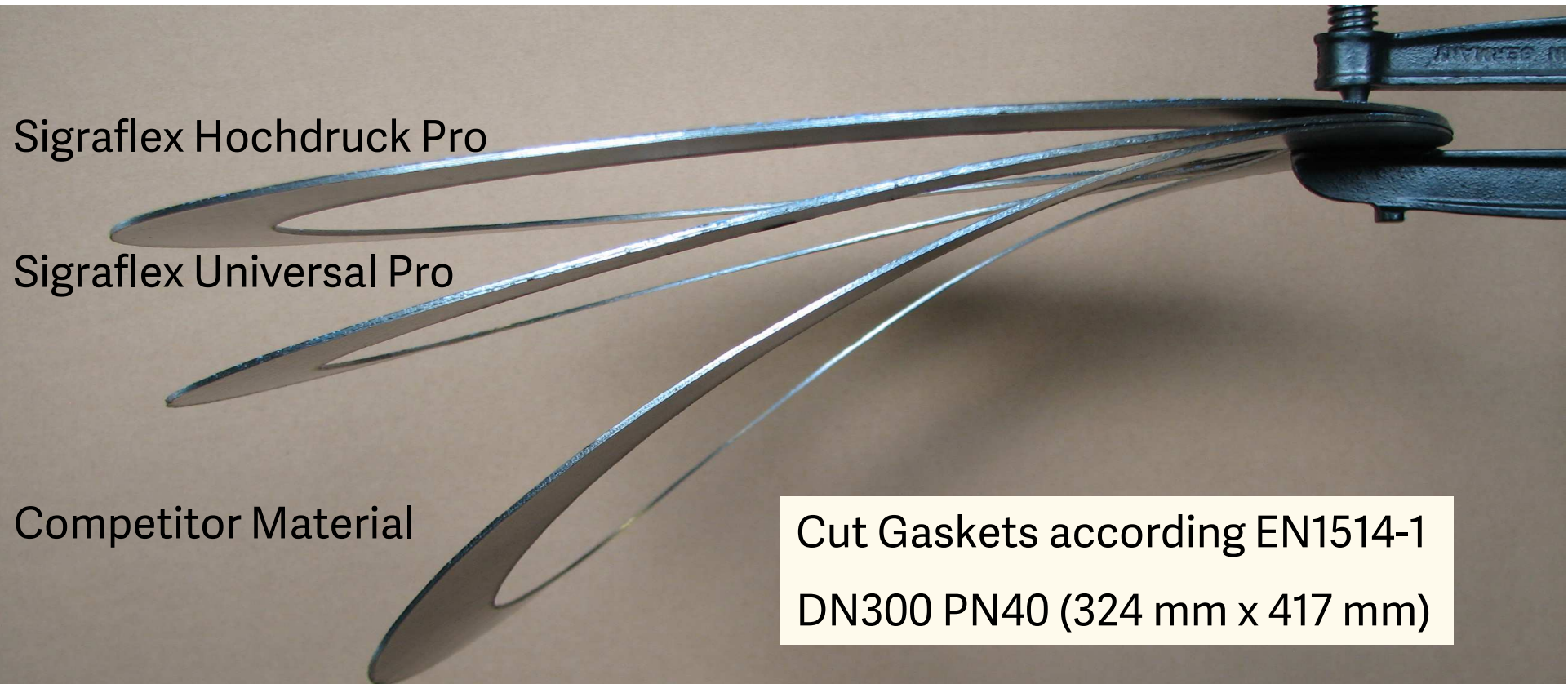
- With Overlapping & glued
- Overlapping, spot welded
- Overlapping, roller seam welded

SGL CARBON makes them by:

- Laser butt welding



Graphite Gaskets - Assembly - Stiffness



Sigraflex Hochdruck Pro

Sigraflex Universal Pro

Competitor Material

Cut Gaskets according EN1514-1
DN300 PN40 (324 mm x 417 mm)

Sealing Material made of SIGRAFLEX® have outstanding properties



Hochdruck, Hochdruck Pro, Universal, Universal Pro and Economy



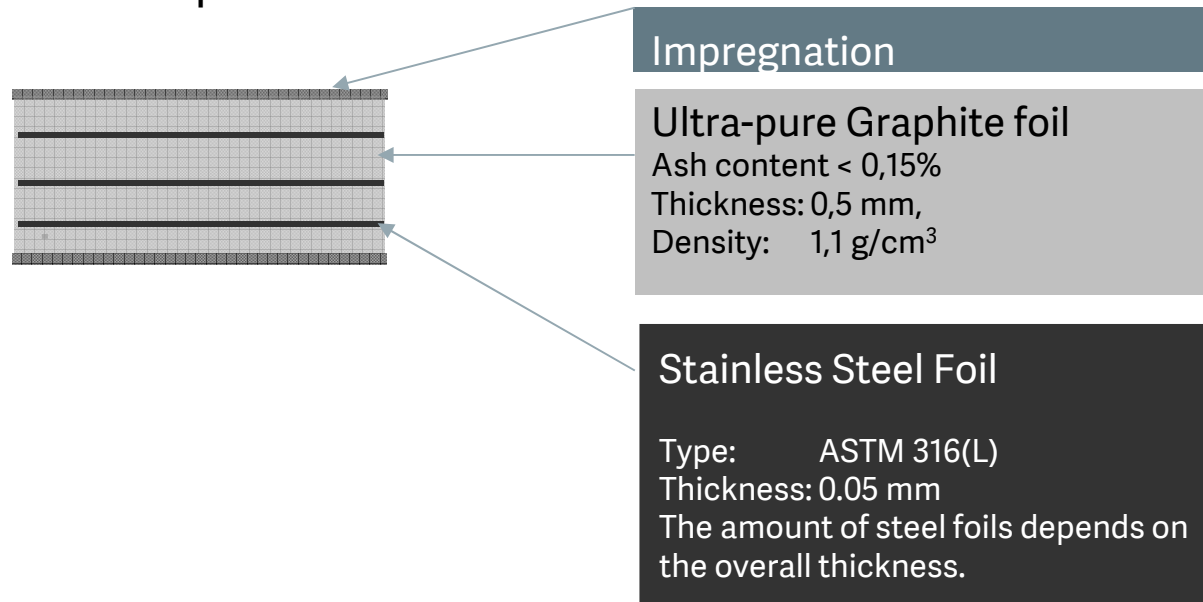
- High Blow-out Safety and thus Process Safety
- Low sticking behaviour to other material due to specific impregnation
- Protects flanges to corrosion
- Applicable at process temperatures of - 250°C to app. 550°C . At temperatures above 450°C we recommend to discuss the application with us
- Resistant to aging and embrittlement
- Not sensitive to scratches
- Free of adhesives and binder agents

The Composition of SIGRAFLEX® HOCHDRUCK (PRO)



Outstanding properties can be attributed to

- The specific composition and
- The adhesive free composite of SIGRAFLEX® Hochdruck Pro sheets



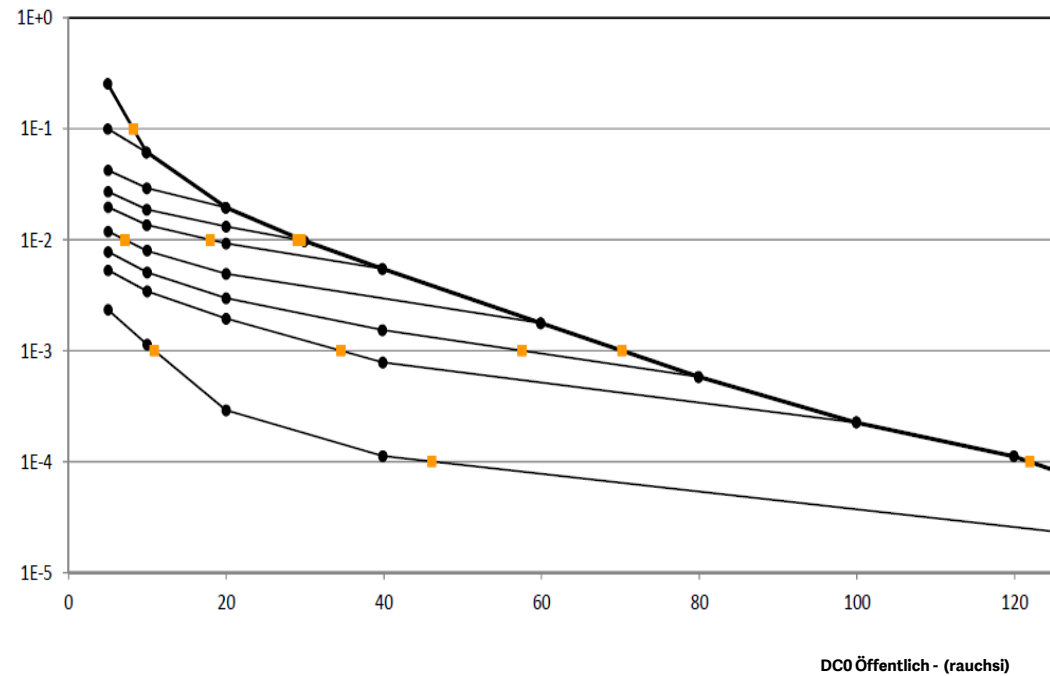
An important factor of Graphite Gaskets are their Mechanical Properties



Minimum surface pressure



Example: Helium leakage rate of Sigraflex Hochdruck V20011Z3I at 40 bar operating pressure according EN 13555



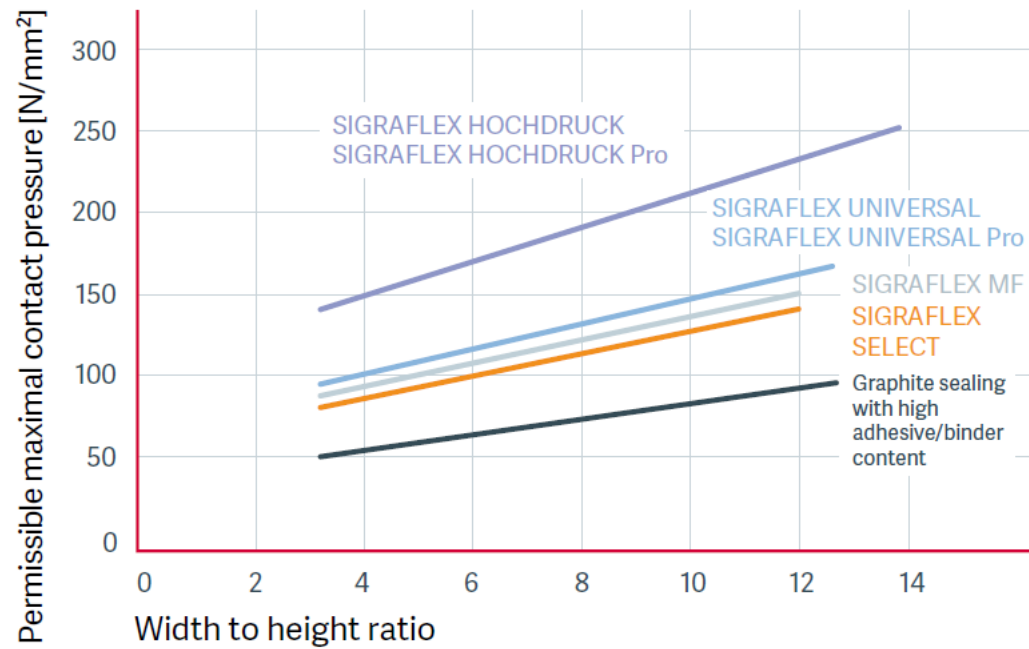
Graphite Gaskets - Mechanical Properties



Maximum surface pressure



Maximum permissible contact pressure for gaskets made of reinforced SIGRAFLEX graphite sheets with a thickness of 2 mm (0.08")



¹⁾ Measured at 300 °C/572 °F (according to DIN 28090-1)

Maximum allowable gasket stress according EN 13555



SIGRAFLEX® HOCHDRUCK *PRO*
after 200 N/mm² at 300 °C

Other Multi layer
tanged reinforced TA
Luft sealing material



After 120 N/mm² at 300 °C



After 150 N/mm² at 300 °C

Surface impregnation



Disassembly is an important criteria when analysing life cycle costs

Specification benefits with SIGRAFLEX®



The technical world we live in is growing increasingly complex. For many years our materials have been subjected to wide ranging tests as specified in the current regulations. SIGRAFLEX materials comply with many different standards and statutory regulations. This represents a safeguard for our customers.



TA Luft (German Clean Air Act) certificates for:

- SIGRAFLEX HOCHDRUCK PRO
- SIGRAFLEX UNIVERSAL PRO
- SIGRAFLEX MF



Broad Base. Best Solutions.

CARBON IN CHEMICAL INDUSTRY

SIGRAFLEX®
Dichtungslösungen aus expandiertem Naturgraphit für den Anlagenbau und die Prozessindustrie.
• Chemisch-thermisch beständig
• Langlebig und zuverlässig

Sealing solutions based on expanded natural graphite for plant engineering and the process industry.
• Chemically and thermally resistant
• Long-lasting and reliable

TA Luft
Quality made in Germany

Inspiration aus dem Meer: Dichten unter extremen Bedingungen.
Inspiration from the Ocean: Sealing under Extreme Conditions.

Expanded Graphite | SGL TECHNOLOGIES GmbH | www.sglgroup.com

For your Process Safety: Sigraflex® Sealing Material is certified



Blow out resistance according VDI 2440:

- ®Sigraflex Hochdruck
- ®Sigraflex Hochdruck Pro
- ®Sigraflex Universal
- ®Sigraflex Universal Pro
- ®Sigraflex Select
- ®Sigraflex MF



For your Process Safety: Sigraflex® Sealing Material is certified



Fire Safe certificate according API 607 and/or BS 6755-2:

- ®Sigraflex Hochdruck
- ®Sigraflex Hochdruck Pro
- ®Sigraflex Universal
- ®Sigraflex Universal Pro
- ®Sigraflex Select
- ®Sigraflex MF

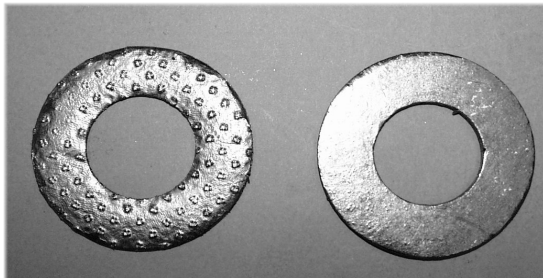


Graphite Gaskets - Temperature Resistance

Temperature ↑
350 °C / 650 °C



Oxidation ↑
 $C + O_2 = CO, CO_2$



Influencing factors on oxidation

- Ash content (small effect)
- Composition of the ash (big effect), depending on raw material and production technology
- Protecting geometry

Oxidation resistance:

safe long term operation or early failure

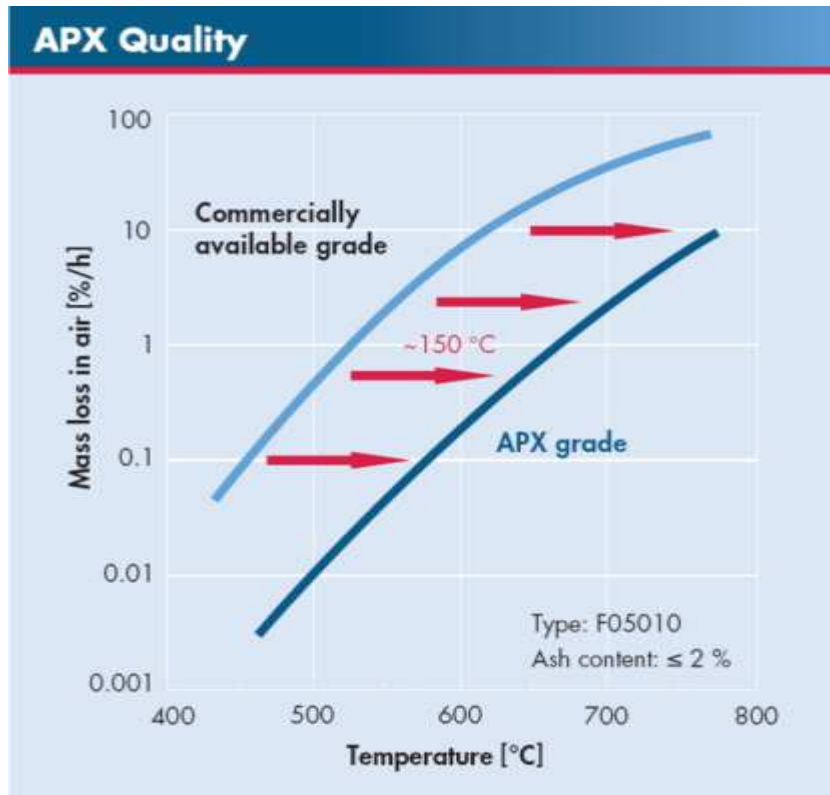
Graphite Gaskets - Temperature Resistance



Significant mass loss,
due to high operating
temperature



Oxidation test



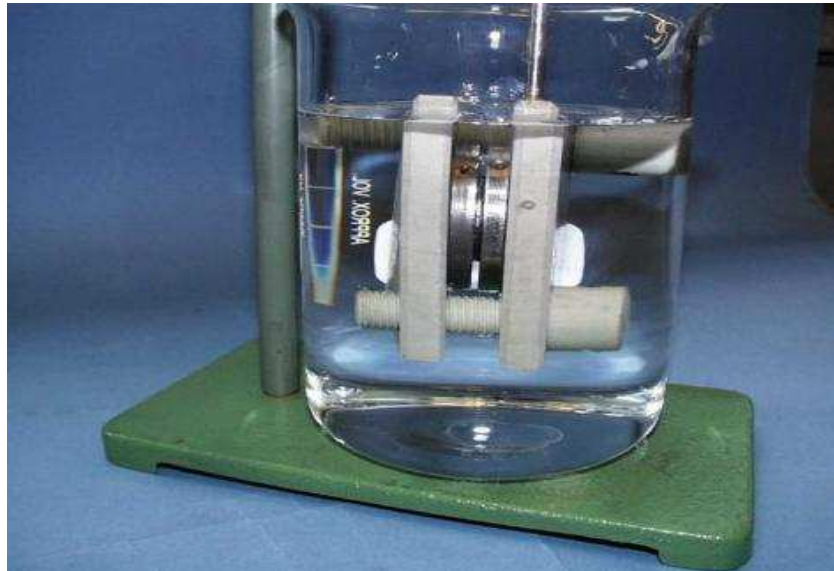
| SIGRAFLEX | | | | |
|--|-------|-------|-------|---------|
| APX2 | APX | E | C | Z |
| Standard 1.0 (capability of 0.7 – 1.3) | | | | |
| ≤ 2.0 | ≤ 2.0 | ≤ 1.0 | ≤ 2.0 | ≤ 0.15 |
| ≥ 98 | ≥ 98 | ≥ 99 | ≥ 98 | ≥ 99.85 |
| ≤ 25 | ≤ 25 | ≤ 10 | ≤ 25 | ≤ 10 |
| ≤ 10 ²⁾ | ≤ 10 | ≤ 10 | ≤ 25 | ≤ 10 |
| ≤ 100 | ≤ 100 | ≤ 50 | ≤ 100 | ≤ 50 |
| < 300 | < 300 | < 300 | < 300 | < 300 |
| ≤ 1 | ≤ 3 | < 4 | ≤ 5 | < 4 |
| yes | yes | yes | yes | yes |
| yes | yes | yes | yes | yes |

Standards related to oxidation in air



- EN 14772
 - 2 - 4 %/h up to >20% at 670 °C (spec is currently under review)
- CAPI / Shell / DIN 28091-4
 - ≤ 4%/h at 670°C, e. g. LECO TGA 601
- Internal test procedures

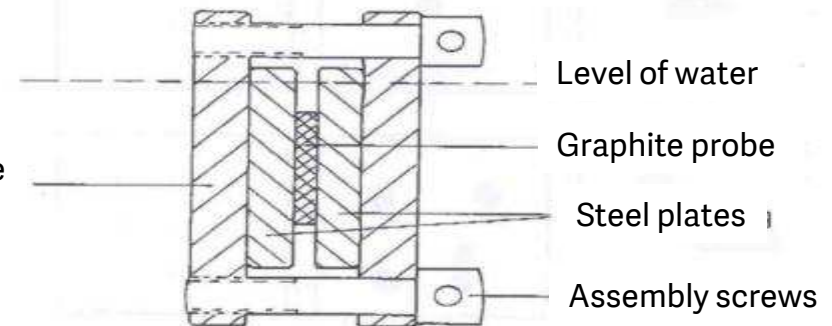
Graphite Gaskets - Flange Corrosion



Polypropylene plates

Method of test
in SGL laboratory

Test at room temperature
with distilled water



Graphite Gaskets - Flange Corrosion after 2 month



SGL laboratory results:



Stainless steel

1.4057

Stainless steel

1.4571

> 1000 ppm Sulfur
> 50 ppm Chloride

< 300 ppm Sulfur
< 20 ppm Chloride

How to evaluate Graphite Gaskets?

→ Flanges, Screws and Gasket
Have an equal importance



The gasket however represents only
a small proportion of the overall costs



SIGRAFLEX - Long term stability



The selection of a high quality gasket increases the economic performance

- Assembly time ↓
- Gasket monitoring ↓
- Gasket failures ↓
- Disassembly time ↓



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Downloads Corporate
Social Responsibility

→ Downloads Products

Graphite and
Carbon Electrodes

Downloads
Cathodes and
Furnace Linings

Equipment Solutions
and Services

Process Solutions

Fine Grain Graphite

→ Expanded
Graphite

Carbon Fiber-
Reinforced Carbon
and Felt

Carbon Fibers

Composite
Materials

Composite
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